Psychological Assessment
2014, Vol. 26, No. 3, 865–877

1040-3590/14/$12.00 DOI: 10.1037/a0036428

Accuracy of Self-Reported Versus Actual Online Gambling Wins and Losses

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This study is the first to compare the accuracy of self-reported with actual monetary outcomes of online fixed odds sports betting, live action sports betting, and online casino gambling at the individual level of analysis. Subscribers to bwin.party digital entertainment's online gambling service volunteered to respond to the Brief Bio-Social Gambling Screen and questions about their estimated gambling results on specific games for the last 3 or 12 months. We compared the estimated results of each subscriber with his or her actual betting results data. On average, between 34% and 40% of the participants expressed a favorable distortion of their gambling outcomes (i.e., they underestimated losses or overestimated gains) depending on the time period and game. The size of the discrepancy between actual and self-reported results was consistently associated with the self-reported presence of gambling-related problems. However, the specific direction of the reported discrepancy (i.e., favorable vs. unfavorable bias) was not associated with gambling-related problems.

Keywords: gambling, self-report accuracy, overestimation, underestimation, Brief Bio-Social Gambling Screen

Studies that have compared industry gambling revenues with self-reported expenditures suggest that players report their losses inaccurately (Volberg, Gerstein, Christiansen, & Baldridge, 2001; Wood & Williams, 2007). However, to arrive at this conclusion, the extant research on this topic has compared average self-reported losses with total gambling industry revenues for a particular time period (Blaszczynski, Dumlao, & Lange, 1997; Wood & Williams, 2007). This approach reports cohort-based (i.e., aggregated) rather than individual-based information. With only cohort-level data, it is impossible to examine whether gamblers employ systematic biases regarding their losses. It is reasonable to assume, for example, that some gamblers discount their losses more than others. Some authors have validated self-reported retrospective losses against the expenditures by having study participants use weekly or daily prospective diaries (Blaszczynski, Ladouceur, Goulet, & Savard, 2008; Williams & Wood, 2004a). Indeed, prospective diaries seem to provide a more accurate approximation of actual gambling outcomes than do retrospective recollections when compared with total revenues (Williams & Wood, 2004a). Moreover, this approach potentially can provide an opportunity to identify individual biases (e.g., by calculating a discrepancy between prospective and retrospective reports for the same gambler). Nevertheless, the abovementioned studies aimed to identify the average overestimation or underestimation of net gains and losses. This body of research reflects pooled reported outcomes and no individual-player-level comparisons. Furthermore, Williams and Wood (2004a) removed records when the gambler reported winning money or breaking even. Without these results, the reported total dollars lost might have been biased toward greater losses. In addition, although prospective diaries can serve as a proxy (i.e., a substitute measurement) for actual gambling outcomes, the reliability of the obtained scores and the validity of the self-reported

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This article was published Online First April 7, 2014.

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The Division on Addiction at the Cambridge Health Alliance receives funding support from a variety of sources, including the following resources: bwin.party Interactive Entertainment, AG; The Century Council; St. Francis House; National Institutes of Health (i.e., National Institute on Drug Abuse, National Institute on Alcohol Abuse and Alcoholism, National Institute of Mental Health); Substance Abuse and Mental Health Services Administration (SAMHSA); The National Center for Responsible Gambling (NCRG); Massachusetts Council on Compulsive Gambling; and the University of Nevada, Las Vegas.

We extend special thanks to Tasha Chandler, Heather Gray, Richard LaBrie, Debi LaPlante, and Sarah Nelson for their support and work on this project. We jointly accept responsibility for the content of this article. Julia Braverman had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. None of these supporters or any of the authors has personal interests in bwin.party and its associated companies that would suggest a conflict of interest.

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values compared to actual outcomes remain questionable (Williams & Wood, 2004a). To our knowledge, no study has attempted to identify individual reporting biases for gambling outcomes and no study has provided a comparison between self-reported and actual gambling outcomes at the level of individual players.

The investigation of these estimation biases holds the potential to open a new perspective for gambling research. If the discrepancies between actual and self-reported gambling outcomes differ from person to person, then it is worth examining moderators (e.g., demographic characteristics, gambling experience, optimism, and/or gambling-related problems) that might influence the degree and direction of these biases. Collecting individual-level objective and independent betting data and comparing these with self-reported results might provide the answers to these questions. In the current study, we collected Internet gamblers' estimations of their losses and winnings and validated these estimations against their records of actual gambling activity.

Previous research, based on accumulated data from land-based gambling facilities, also has reported that the accuracy of expenditure estimation depends upon the time period in the question. Gamblers are typically more accurate when asked to estimate their losses and winnings for shorter rather than longer temporal windows (Blaszczynski et al., 1997; Walker et al., 2006). This literature suggests the following hypothesis.

> *Hypothesis 1:* On average, online gamblers will be more accurate if asked about their losses and winnings during the last 3 months compared to the last 12 months.

Previous studies comparing self-reported expenditures with actual gaming revenues concluded that, on average, gamblers underestimate their total losses (Williams & Wood, 2004a; Wood & Williams, 2007). This suggests our second hypothesis.

> *Hypothesis 2:* A majority of gamblers favorably distort their results. This majority consists of two subgroups: net winners who overestimate their gains and net losers who underestimate their losses.

Individual characteristics (i.e., moderators) relate to estimation accuracy and the direction of discrepancy between self-reported and actual results. No previous studies have investigated the effect of moderators (e.g., gambling experience) on estimating gambling outcomes. However, several gaming studies (e.g., experiments with chess and bridge players) have shown that expertise in a field enhances encoding, recognition, and recall of events pertaining to that field (Engle & Bukstel, 1978; Gobet & Simon, 1996). We based our third hypothesis on these results.

> *Hypothesis 3:* More experienced gamblers will be more accurate. In other words, the self-reported results and actual results of more experienced gamblers will reflect smaller discrepancies than those of less experienced gamblers.

Previous studies demonstrated an association between optimism and players continuing their gambling behaviors. For example, in one study optimists maintained positive expectations and continued gambling after losing more than did pessimists (Gibson & Sanbonmatsu, 2004). Gambling persistence (in this instance, defined by time and number of trials chosen to gamble; Hills, Hill, Mamone, & Dickerson, 2001) and positive gambling expectations (Gillespie, Derevensky, & Gupta, 2007; Shead, Callan, & Hodgins, 2008) are associated with gambling-related problems.[1] Our fourth hypothesis pertains to this phenomenon.

> *Hypothesis 4:* Gamblers who favorably bias estimates of their gambling outcomes (i.e., underestimate losses and overestimate winnings) are more likely to have gambling-related problems, as evidenced in this study by positive Brief Bio-Social Gambling Screen results.

If problem gamblers have more selective memories of their past gambling experiences than recreational gamblers do, they might have more biased recollections and greater distortions. There are many reasons why this circumstance could be so. For example, previous studies have reported that pathological gamblers experience arousal during the gambling process (Hills et al., 2001). Other studies have demonstrated that arousal increases selective attention and enhances arousal-induced bias (i.e., bias to recall primarily salient events; Echterhoff & Wolf, 2012; Sutherland & Mather, 2012). These selected memories might not include large gains or losses. These memories could, for example, reflect co-occurrences with certain important life events (e.g., choosing lottery numbers based on loved ones' birthdays). These selective memories might mediate general estimation inaccuracy for gambling expenditures. Another reason for greater self-reported distortion of gambling results among problem gamblers might be the comorbidity of other mental health problems, especially substance abuse and mood disorder (Black & Moyer, 1998; Shek, Chan, & Wong, 2012). Individuals with mood disorders and substance abuse tend to experience substantial disruption of various cognitive functions, including processing, attention, and memory bias (Baños, Medina, & Pascual, 2001; Coles & Heimberg, 2002; Evans, Craig, Oliver, & Drobes, 2011). Our fifth hypothesis is based on the possible influence of arousal and comorbid mental disorders on individuals with gambling-related problems.

> *Hypothesis 5:* Gamblers who have gambling-related problems have greater discrepancies between self-reported and actual outcomes than gamblers who do not have such problems.

We tested each of these five hypotheses with gambling data derived from three games of chance: fixed odds sports betting, live action sports betting, and online casino play. Fixed odds sports bets are bets where the odds and the wager are set before the event (e.g., game or match) begins. The bettors wager money on the final outcome of the event (e.g., which team will win). Live action sports bets are wagers made while the event is taking place. Live action sports bets include wagers on which soccer player will score the next goal or who will win the next point or game in a tennis match. Online casino play refers to computer programs that simulate blackjack, roulette, video poker, and other table games found in a casino. In addition to testing these hypotheses, we examined the gambling data for associations between various moderators (e.g., age, gender, and self-reported income of gamblers)[2] and the accuracy of players in estimating their gambling outcomes. We also investigated the association between favorable and unfavorable estimation bias toward gambling outcomes and absolute estimation accuracy. We wanted to learn whether favorable estimation bias is more or less accurate than unfavorable estimation bias.

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[1] Researchers focusing on gambling use different operational definitions for gambling-related problems. When the full clinical evaluation is implausible to achieve, the researchers use various proxies such as self-reported problems, prevalidated screening scales, and clinical evaluations. For the purpose of the present study, we operationally define problematic gamblers as those who received a positive Brief Bio-Social Screen (BBGS) score. We will use the terms *problematic gamblers* and *gambling-related problems* throughout the paper to refer to previous findings that used these terms with various operational definitions that are dependent on the specific study.

Finally, using data across the three games, we tested the following variant of Hypothesis 4.

> *Hypothesis 6:* Gamblers who consistently distort their gambling outcomes favorably (e.g., underestimate losses or overestimate winnings) across games are more likely to have gambling-related problems.

Method

Participants

The participants were 2,259 respondents to an online brief survey focusing on specific-game results. The Internet betting service provider bwin.party sent this survey to a random sample of 100,000 of their registered customers. bwin.party is the world's largest publicly traded online gambling facility; with millions of customers worldwide, it is the largest online gambling company in the world. Its core business is sports betting. After excluding records that either contained technological errors or appeared to be duplicates, we obtained a sample of 2,150 participants. We then removed the data of 144 participants who filled out the survey in English and French. Their data was corrupted due to an incorrect translation. Everyone who received the survey was assigned randomly to answer (a) a battery of game-specific questions about the financial outcomes of their gambling, (b) a single nonspecific question about his or her total gambling results for the given period of time, or (c) no money-related question at all. For the purpose of the current study we analyzed data from the 773 participants who answered game-specific questions.[3]

From this pool we derived three separate subject pools for each of the games: Fixed Odds ($n = 653$), Live Action ($n = 514$), and Online Casino ($n = 142$). For each of these subject pools we included only participants who had played the target game on at least two different days since their date of first deposit. For each of these subject pools, we separated participants who answered questions about their last 12 months of gambling from those who answered questions about their last 3 months. Finally, we excluded participants who did not play (i.e., their gambling record contains zero bets) during the designated period of time. This approach to grouping participants yielded six different cohorts: two (i.e., past 12 and past 3 months) for each type of gambling activity. There were overlaps among the cohorts. One hundred fifty-six participants from the past 3-month cohort played both Live Action and Fixed Odds, and 24 participants were engaged in all three types of gambling activities. For the past 12-month cohort, 183 participants gambled Live Action and Fixed Odds and 36 participants played all three types of game. Figure 1 shows the step-by-step process that resulted in six subject pools (i.e., 3 types of gambling × 2 lengths of time).

Procedure

The average age of subscribers in the analytic data set was 35.88 years ($SD = 11.25$). The respondents were from seven countries: most commonly, Germany (38% of 2,006), Italy (26%), Spain (11%), and Poland (8%). The remaining 17% of respondents were from Portugal, Greece, and Austria. Only 118 (6%) of the 2,006 subscribers were female; the remaining 1,888 (94%) were male.

Our actual betting data included the aggregated transactions for each respondent for each day of betting for each of the three types of gambling activity (i.e., fixed odds sports betting, live action sports betting, and online casino play). Our self-reported data contained responses to an Online Gambling Experience Survey sent by bwin.party to a random sample of registered customers. We calculated discrepancy variables based on these actual and self-reported measures.

Measures

Actual betting data. Our gambling behavior measures represented daily aggregates of betting activity records, starting with the first bwin.party betting day. The daily aggregates included the game played (i.e., Live Action, Fixed Odds, or Online Casino), the number of bets, the amount of money wagered, and the winnings credited to the bettor's account on that day for that product. On the basis of these daily aggregates, for each bettor and game combination, we calculated total stakes wagered (i.e., the sum of the amounts wagered on the specific game), total amount won (i.e., the sum of the winnings credited), total number of bets (i.e., the sum of the numbers of bets), and the total active days (i.e., the number of days within the time period when the bettor placed at least one bet on the specified game; this is a proxy for gambling experience). From these basic variables, we calculated the following data-driven variables: average bet size (i.e., total stakes wagered divided by total number of bets) and an actual net outcome (i.e., total amount won minus total amount bet).

Online gambling experience survey. The online survey was originally composed in English and then translated into eight other languages (i.e., French, German, Spanish, Portuguese, Greek, Polish, Danish, and Italian). We ordered the translations of the Brief Bio-Social Gambling Screen from Language Scientific (formerly RIC International, Inc.), a professional translation company. All translations were back translated and vetted by a panel of international experts. The full translation text is available from the authors upon request.

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[2] We assessed self-reported income by a single item question: "Looking at the options below, please select the option that best represents your total household income during the past 12 months before taxes. Include yourself and all family members who lived with you. If you are uncertain, please enter your best estimate." The options presented 11 ranges of total household income, from $<$ 19,000 EU to 200,0000 EU+.

[3] The game-specific questions asked "How much money did you win or lose during the last 3(12) months on each type of gambling activity at bwin? (Record your net losses or winnings—how much you are behind or ahead.)" This followed by the list of gambling activities available through bwin.party (i.e., fixed-odds sports betting, live action sports betting, poker, casino-type games, and other games). For the total money condition the questions just stated "at bwin." bwin.party did not provide actual data for poker; therefore, it was not possible to compare self-reported and actual total expenditures across all games.

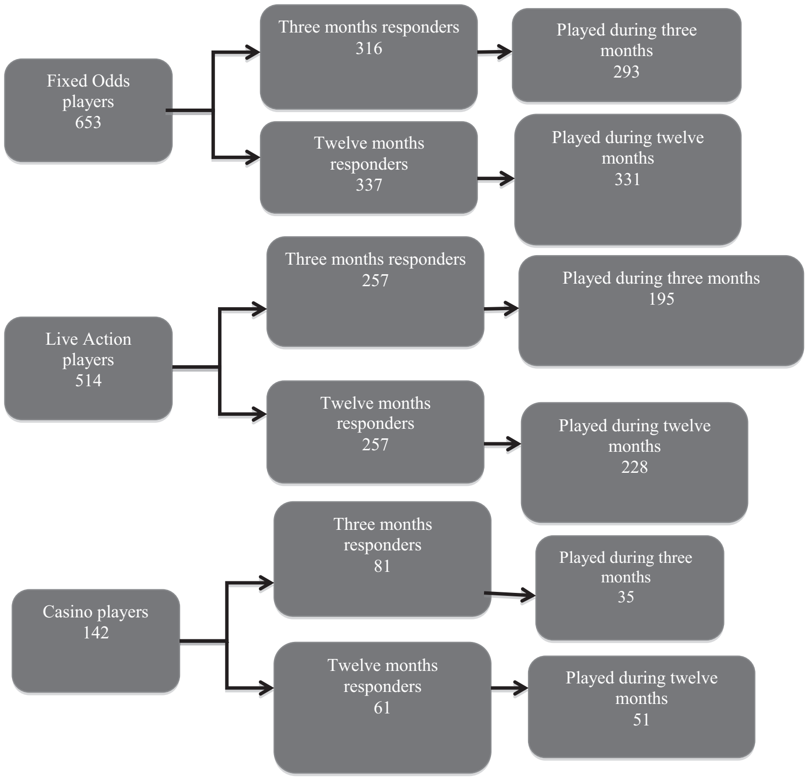
Fixed Odds players 653
Three months responders 316
Played during three months 293
Twelve months responders 337
Played during twelve months 331
Live Action players 514
Three months responders 257
Played during three months 195
Twelve months responders 257
Played during twelve months 228
Casino players 142
Three months responders 81
Played during three months 35
Twelve months responders 61
Played during twelve months 51

Figure 1. Subject pools derived from valid survey respondents.

The survey consisted of three parts: (a) Brief Bio-Social Gambling Screen (BBGS; Gebauer, LaBrie, & Shaffer, 2010); (b) a question about personal/household income; and (c) the following question about results: "How much money did you win or lose during the last 3 (12) months on each type of gambling activity at bwin.party? (Record your net losses or winnings—how much you are behind or ahead)." We assigned participants randomly to estimate their financial results for either 3 months or 12 months of gambling.

For each participant, we calculated a BBGS score, the number of questions on the BBGS that the participant responded affirmatively (0, 1, 2, or 3), and BBGS status, whether or not the participant answered affirmatively to at least one of the questions on the BBGS (i.e., BBGS-Positive vs. BBGS-Negative). In addition, for each bettor and type of game, we recorded self-reported net outcome, the bettor's estimate of actual net outcome.

For each participant and game played, we defined *bias* as (self-reported net outcome − actual net outcome)/average bet size. This is a measure of discrepancy between the self-reported and actual outcomes that also takes into account the participant's average bet size. For example, consider two gamblers who each report losing 100 euros but actually lost 200 euros. Suppose that the first gambler has an average bet size of 5 euros while the second has an average bet size of 50 euros. The bias for the first gambler is $[-100 - (-200)]/5 = 20$, and the bias for the second is $[-100 - (-200)]/50 = 2$.

This operational definition allows us to avoid an artificial correlation between the size of the discrepancy and the total amount wagered or the size of the discrepancy and the average bet size. Positive scores mean a favorable bias toward gambling results (i.e., underestimation of losses or overestimation of net gains). Negative scores reflect an unfavorable bias toward gambling results (i.e., overestimation of losses or underestimation of net gains). We will refer to gamblers with positive bias scores as those with a "favorable bias" and gamblers with negative bias scores as those with an "unfavorable bias." We also calculated absolute discrepancy (i.e., $|bias|$) to indicate the level of estimation inaccuracy independent of the direction of discrepancy.

Type of gambler by self-report. We separated the cohort into five subgroups based on the combination of bias and actual net outcome. We classified gamblers as "accurate estimators" if their bias score was between −1 and 1; we included the end points of this interval. Accurate estimators reported estimates that were no more than 1 average bet size away from the actual outcomes. We called gamblers "favorably biased" if their bias score was above 1 and called gamblers "unfavorably biased" if their bias score was below −1. The group of favorably biased gamblers consisted of "underestimating losers" (i.e., gamblers with a negative actual net outcome) and "overestimating winners" (i.e., gamblers with a positive actual net outcome). Similarly, the group of unfavorably biased gamblers included "overestimating losers" (i.e., gamblers with a negative actual net outcome) and "underestimating winners" (i.e., gamblers with a positive actual net outcome).

For gamblers who were common to the two cohorts for Live Action sports betting and Fixed Odds sports betting, we created the categorical variable *sports betting consistency*. Those who were favorably biased for both games and those who were unfavorably biased for both sports games were classified as "consistently favorably biased" and "consistently unfavorably biased sports bettors," respectively. We classified gamblers who were favorably biased with respect to one game but unfavorably biased with respect to the other as "inconsistent." We classified gamblers who were accurate estimators on both types of sports betting games as "consistent actual estimators." Those individuals who were accurate estimators with one game but evidenced favorable or unfavorable bias with the other remained unclassified.

For those bettors common to all three cohorts, we created the categorical variable *three game consistency*. We classified gamblers as "consistently favorably biased," "consistently unfavorably biased," and "consistently accurate" if they were favorably biased, unfavorably biased, or accurate, respectively, for each of the three games under investigation. We classified those who favorably biased the outcome of some games but unfavorably biased the outcomes of other games as "inconsistent." We did not classify bettors who were accurate estimators of some game outcomes but who favorably or unfavorably biased the outcome of at least one other game.

Primary Statistical Analyses

To identify outliers with high absolute discrepancy, we conducted two cluster analyses (each with $k = 2$), one using the 3-month cohort and one using the 12-month cohort. We called gamblers in the cluster with the highest mean value of absolute discrepancy "exceptionally inaccurate" and gamblers in the cluster with the lowest mean value "regular." Due to the nonnormal distribution of all our variables, we conducted nonparametric tests to assess our hypotheses. In particular, we conducted Mann–Whitney U tests to compare the distributions of absolute discrepancy for favorably and unfavorably biased gamblers. We calculated Spearman correlations to investigate associations between numerical variables (e.g., bias and total active days). We conducted chi-square tests—replacing them with the Fisher's exact tests where cell counts were less than 5—to examine relationships between categorical variables (e.g., type of gambler by self-report and BBGS status). We repeated these analyses for each game cohort (i.e., Fixed Odds, Live Action, and Casino) separately. In addition, we conducted a chi-square analysis to examine whether gamblers who participate in multiple activities tend to be consistently favorably or unfavorably biased across all games they play. We conducted another chi-square test to examine if such a consistency related to the existence of gambling-related problems.

Results

To examine each of the hypotheses, we conducted the data analysis separately for each of the three gambling activities (i.e., Fixed Odds, Live Action, and Casino) and for two time periods (i.e., 3 months vs. 12 months).

Fixed Odds Sports Betting

Descriptive statistics. The mean ages for the gamblers who participated in Fixed Odds sports betting were 36.32 years (SD = 11.10, range = 18–74) for the 3-month cohort and 36.24 years (SD = 11.26, range = 18–75) for the 12-month cohort. There were 13 (4%) women in the 3-month cohort and 22 women (17%) in the 12-month cohort.

Table 1 summarizes the self-reported and actual outcomes for Fixed Odds sports betting for the 3- and 12-month cohorts. Gamblers in the 3-month cohort, as a group, spent 5,139.22 euros but believed they had lost 17,105.34 euros. This reflects an overestimation of losses by a factor of 3. Gamblers in the 12-month cohort, as a group, spent 45,535.67 euros but believed they had spent 89,068.79 euros. This reflects an overestimation of losses by a factor of 2.

As we described earlier, we calculated the discrepancies between the actual net outcomes and the self-reported net outcomes. We assigned each fixed odds sports bettor a discrepancy score represented by the average bet size units. Table 2 summarizes the bias score and absolute discrepancy scores for Fixed Odds sports betting in average bet size units.

To avoid the effects of outliers on the results, we conducted a cluster analysis using absolute discrepancy to reveal gamblers who were exceptionally inaccurate in estimating their results. We compared these outliers with their counterpart regular gamblers and analyzed them separately. The 2-group cluster analyses revealed one exceptionally inaccurate Fixed Odds sports bettor among the 3-month cohort (exceptionally inaccurate cluster: M = 3,098.49; regular cluster: M = 33.53, SD = 86.57) and 10 exceptionally inaccurate Fixed Odds sports bettors among the 12-month cohort (exceptionally inaccurate cluster: M = 1,366.17, SD = 669.10; regular cluster: M = 52.86, SD = 100.01).

Next, we examined the relationship between the direction and the magnitude of the discrepancy between self-reported and actual results. We conducted the Mann–Whitney U test comparing the absolute discrepancy values for regular live action sports bettors with favorable bias to the absolute discrepancy values for regular

Table 1
Self-Reported and Actual Net Outcomes for Fixed Odds Gambling for 3- and 12-Month Cohorts (in Euros)

Variable	3-month cohort (N = 293) Actual net outcome	3-month cohort (N = 293) Self-reported net outcome	12-month cohort (N = 331) Actual net outcome	12-month cohort (N = 331) Self-reported net outcome
M (SD)	−17.54 (413.03)	−58.38 (485.60)	−137.57 (810.25)	−269.09 (2,558.91)
Minimum	−1,892.30	−3,000.00	−9,186.51	−40,000.00
Median	−16.50	−10.00	−34.62	−25.00
Maximum	5,544.30	5,000.00	4,770.34	4,000.00
Total	−5,139.22	−17,105.34	−45,535.67	−89,068.79

Table 2
Discrepancy for Fixed Odds Gambling for 3 and 12 Months Before the Survey (in Average Bet Size Units)

	3-month cohort ($N = 293$)		12-month cohort ($N = 331$)	
Variable	Bias	Absolute discrepancy	Bias	Absolute discrepancy
M (*SD*)	−11.30 (203.33)	43.99 (198.83)	10.66 (284.73)	92.54 (269.44)
Minimum	−3098.49	0	−2090.74	0
Median	1.16	7.82	2.75	17.79
Maximum	989.88	3,098.49	2,921.73	2,921.73

live action sports bettors with unfavorable bias. There were no statistically significant results. There was no support for the hypothesis that the direction of the discrepancy is associated with its magnitude. There was no correlation between age and either absolute discrepancy or optimism score. There was a positive correlation between age and total active days within the 3- and 12-month cohorts, 3-month cohort: $\rho\ (292) = 0.25$, $p < .01$; 12-month cohort: $\rho\ (319) = 0.25$, $p < .01$.

We found no association between gender and any of the other variables; however, the paucity of females in this sample limits statistical power for these comparisons.

Hypotheses Testing

Hypothesis 1. As predicted, the gamblers in the 3-month cohort were more accurate in estimating their gambling results than gamblers in the 12-month cohort, as measured by absolute discrepancy (3-month cohort: $Mdn = 7.80$, range = 989.88; 12-month cohort: $Mdn = 16.26$, range = 690.81; Mann–Whitney $U\ (613) = 57{,}424$, $p < .01$, $r = .19$).[4]

Hypothesis 2. About half of the gamblers, 148 (51%) from the 292 in the 3-month cohort and 179 (56%) from the 321 in the 12-month cohort, favorably biased their gambling outcomes. Of those with favorable bias, most (122 [82%] from the 3-month cohort and 151 [84%] from the 12-month cohort) were losing gamblers who underestimated their losses. The rest were winning gamblers who overestimated their winnings. About one third (105 [36%] from the 3-month cohort and 120 [37%] from the 12-month cohort) unfavorably biased their gambling outcomes. Of those with unfavorable bias, most (71 [68%] from the 3-month cohort and 78 [65%] from the 12-month cohort) were losing gamblers who overestimated their losses. The rest were winning gamblers who underestimated their profits. About 10% of gamblers—that is, 39 (13%) from the 3-month cohort and 22 (7%) from the 12-month cohort—precisely estimated their outcomes.

Of the 11 exceptionally inaccurate gamblers, 6 (55%) were unfavorably biased (i.e., 1 from the 3-month cohort and 5 from the 12-month cohort) and 5 (45%) were favorably biased.

Overall, these results support the hypothesis that the majority of gamblers are favorably biased about their results; however, a substantial number of gamblers were unfavorably biased about their results.

Hypothesis 3. The hypothesis that gambling experience is negatively associated with self-report discrepancy was not supported for fixed odds sports betting activity. On the contrary, the total active days was correlated positively with the absolute discrepancy score for both the 3-month and 12-month cohorts; 3 months: $\rho\ (292) = 0.24$, $p < .01$; 12 months: $\rho\ (321) = 0.46$, $p < .01$. This means that, for both the 3-month and 12-month cohorts, the more experienced gamblers were less rather than more accurate. We also examined the association between bias and total active days. This test revealed that bias was not correlated with total active days for the 3-month cohort, but it was positively correlated with total active days for the 12-month cohort, $\rho\ (321) = 0.18$; $p < .01$. This implies that gambling experience increasingly influenced a more favorable perception of gambling results.

Hypothesis 4. The results did not support the hypothesis that gamblers who exhibit favorable bias are more likely to have gambling problems. On the contrary, for the 3-month cohort, the percentage of BBGS-Positives among favorably biased gamblers (43/147 = 29%) was lower than the percentage of BBGS-Positives among unfavorably biased gamblers (44/106 = 42%, $\chi^2 = 4.10$, $p < .05$, Cramer's $V = 0.12$). Moreover, the BBGS-Positives from the 3-month cohort evidenced more pessimistic estimates of results ($Mdn = -0.19$, range = 651.49) than the BBGS-Negatives ($Mdn = 1.69$, range = 1,150.36; Mann–Whitney $U\ (292) = 7{,}732$, $p < .03$, $r = .14$). These results reveal that, within the 3-month cohort, gamblers who reported having gambling-related problems estimated their outcomes unfavorably (i.e., they overestimate losses and underestimate winnings) rather than favorably. This association was not evident among the 12-month cohort. We found no relationship between type of gambler by self-report and BBGS status ($p = .76$) and no relationship between bias and BBGS status within the 12-month cohort ($p = .5$).

Hypothesis 5. All analyses consistently confirmed the hypothesis that low accuracy of self-reported gambling results is associated with gambling-related problems. Mann–Whitney *U* tests revealed that, for both the 3-month and 12-month cohorts, the distributions for absolute discrepancy among BBGS-Positives were higher than the distributions among BBGS-Negatives (3-month cohort: $Mdn = 5.73$, range = 989.88 vs. $Mdn = 14.45$, range = 473.52, Mann–Whitney $U\ (292) = 11{,}910$, $p < .01$, $r = .23$; 12-month cohort: $Mdn = 14.84$, range = 69.81 vs. $Mdn = 25.16$, range = 500.55, Mann–Whitney $U\ (321) = 10{,}098$, $p =$

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[4] This result might look surprising given that overestimation for the 3-month cohort was 3 times but overestimation for the 12-month cohort was only twice as much. However, (a) removal of the outliers and (b) the different method of calculation of discrepancy—not by total money, but by the number of average bets—is responsible for this difference.

Table 3

Self-Reported and Actual Net Outcomes for Live Action Gambling for 3 and 12 Months Before the Survey (in Euros)

	3-month cohort (N = 195)		12-month cohort (N = 228)	
Variable	Actual net outcome	Self-reported net outcome	Actual net outcome	Self-reported net outcome
M (*SD*)	−87.72 (297.87)	−56.21 (310.64)	−182.04 (891.40)	−80.82 (662.93)
Minimum	−1,964.75	−2,500.00	−4,373.28	−3,000.00
Median	−11.08	−10.00	−10.46	−16.00
Maximum	1,161.81	1,500.00	8,405.38	8,000.00
Total	−17,105.40	−10,960.95	−41,505.12	−18,426.96

.05, $r = .11$). Because there was only one exceptionally inaccurate gambler in the 3-month cohort, we applied a chi-square analysis to the combined data from the 3- and 12-month cohorts. Of the 11 exceptionally inaccurate gamblers and 613 regular gamblers, 7 (64%) and 164 (27%), respectively, were BBGS-Positive. Exceptionally inaccurate gamblers were more likely than regular gamblers to experience gambling-related problems (Fisher's exact test, $p = .012$, $OR = 4.78$).

Live Action Sports Betting

Descriptive statistics. The mean ages of the gamblers who participated in live action sports betting were 35.38 years (SD = 11.6, range = 18–74) for the 3-month cohort and 35.18 years (SD = 10.93, range = 18–74) for the 12-month cohort. There were 5 (3%) women in the 3-month cohort and 15 (7%) women in the 12-month cohort. Table 3 summarizes the self-reported and actual outcomes for live action sports betting for the 3- and 12-month cohorts. During their 3 months, gamblers in the 3-month cohort, as a group, lost 17,105 euros but believed they had lost 10,961 euros. This represents an underestimation of losses of 35%. During their 12 months, the gamblers in the 12-month cohort, as a group, lost 41,505 euros but believed they had lost 18,427 euros. This represents a 56% underestimate of losses.

We calculated the discrepancies between the actual net outcomes and the self-reported net outcomes as described previously. We assigned each live action sports bettor a discrepancy score represented by the average bet size units. Table 4 summarizes the discrepancy scores for Live Action sports betting in average bet size units.

To avoid the effects of outliers on the results, as before, we conducted a cluster analysis of absolute discrepancy to reveal gamblers who estimated their results with exceptional inaccuracy. We compared these outliers with their regular counterparts and analyzed them separately for most tests. The two-group cluster analyses revealed 10 exceptionally inaccurate live action sports bettors among the 3-month cohort (exceptionally inaccurate cluster: M = 138.60, SD = 58.03; regular cluster: M = 10.58, SD = 13.90) and 7 exceptionally inaccurate live action sports bettors among the 12-month cohort (exceptionally inaccurate cluster: M = 479.23, SD = 198.99; regular cluster: M = 22.88, SD = 41.01).

Table 4

Self-Reported vs. Actual Discrepancy for Live Action Gambling Outcomes for 3 and 12 Months Before the Survey (in Average Bet Size Units)

	3-month cohort (N = 195)		12-month cohort (N = 228)	
Variable	Bias	Absolute discrepancy	Bias	Absolute discrepancy
M (*SD*)	3.35 (37.75)	17.15 (33.78)	13.11 (100.48)	36.89 (94.35)
Minimum	−267.55	0	−695.49	0
Median	.73	4.60	.63	6.82
Maximum	202.75	267.55	787.29	787.29

Next, we examined the relationship between the direction and the magnitude of the discrepancy between self-reported and actual results. We conducted the Mann–Whitney U test comparing the absolute discrepancy values for regular live action sports bettors with favorable bias to the absolute discrepancy values for regular live action sports bettors with unfavorable bias. There were no statistically significant results. Consequently, there was no support for the hypothesis that the direction of the discrepancy between actual and self-reported results is associated with its magnitude.

Among the 12-month cohort, age was positively correlated with accuracy. That is, older gamblers evidence significantly more accurate self-reported wins and losses (i.e., had lower absolute discrepancy score) than did younger bettors, ρ (220) = −.14, $p <$ .05.

Due to the small number of women in the cohorts, we did not conduct gender analyses.

Hypotheses Testing

Hypothesis 1. As predicted, the live action sports bettors in the 3-month cohort were more accurate estimating their gambling results than gamblers in the 12-month cohort, as measured by absolute discrepancy (3-month cohort: Mdn = 4.13, range = 70.04; 12-month cohort: Mdn = 6.20; range = 246.40); Mann–Whitney U (406) = 23,902; $p < .01$, $r = .15$).[5]

Hypothesis 2. The results of the live action sports bettors did not support the hypothesis that a majority of gamblers favorably bias their gambling outcomes. Slightly less than half of the live action sports bettors (86 [47%] out of the 185 in the 3-month cohort, 105 [48%] of the 221 in the 12-month cohort) evidenced favorable bias. Of these, most (68 [79%] from the 3-month cohort, 95 [90%] from the 12-month cohort) were losing gamblers who underestimated their losses. The rest were winning gamblers who overestimated their profits. About one third (63 [35%] of the

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[5] The numbers do not include the outliers.

3-month cohort and 90 [41%] of the 12-month cohort) unfavorably biased their estimates of their gambling outcomes. Roughly half of those (36 [57%] from the 3-month cohort and 46 [51%] from the 12-month cohort) were losing gamblers who overestimated their losses. The rest were winning gamblers who underestimated their profits. About 15% of gamblers (36 [20%] from the 3-month cohort, 26 [12%] from the 12-month cohort) precisely estimated their outcomes.

Of the 17 exceptionally inaccurate gamblers, 6 (35%) were unfavorably biased (i.e., 4 from the 3-month cohort and 2 from the 12-month cohort) and 11 (55%) were favorably biased (i.e., 6 from the 3-month cohort and 5 from the 12-month cohort).

Overall, these results support the hypothesis that the majority of gamblers are favorably biased toward their gambling results; however, a substantial number of gamblers are unfavorably biased toward their gambling outcomes.

Hypothesis 3. The absolute discrepancy score was correlated positively with total active days for both Live Action sports betting cohorts; 3 months: ρ (185) = 0.37; p = .01; 12 months: ρ (185) = 0.60, $p < .01$. Therefore, the hypothesis that gambling experience is positively correlated with self-report accuracy was not supported for live action gambling activity. On the contrary, for both the 3-month and 12-month cohorts, the more experienced gamblers were less accurate. In addition, there was a positive correlation between bias and total active days in live action sports betting, 3 months: ρ (185) = 0.27, $p < .01$; 12 months: ρ (185) = 0.13, p = .05, indicating that more experienced gamblers were also more favorably biased toward their estimated losses.

Hypothesis 4. The results of live-action cohort analysis did not support the hypothesis that gamblers who distort their outcomes favorably were more likely to have gambling-related problems. A chi-square test did not reveal a significant association between BBGS status and type of gambler by self-report. We conducted Mann–Whitney *U* tests to examine whether we could detect a difference in bias for BBGS-Positives and BBGS-Negatives. The tests did not detect a difference either within the 3-month cohort or within the 12-month cohort.

Hypothesis 5. Mann–Whitney *U* tests revealed that, for both the 3-month and 12-month cohorts, the distributions for absolute discrepancy among BBGS-Positives were higher than the distributions among BBGS-Negatives (3-month cohort: *Mdn* = 3.09, range = 70.04 versus *Mdn* = 9.98, range = 69.83, Mann–Whitney *U* (185) = 4,911, $p < .01$, r = .20; 12-month cohort: *Mdn* = 5.65, range = 246.40 vs. *Mdn* = 12.23, range = 224.10, Mann–Whitney *U* (221) = −5,625, $p < .01$, r = .18). We also conducted a chi-square analysis to explore if membership in the exceptionally inaccurate group was independent of BBGS status. Of the 17 exceptionally inaccurate gamblers and 406 regular gamblers, 13 (77%) and 121 (30%), respectively, were BBGS-Positive. Exceptionally inaccurate gamblers were significantly more likely to experience gambling-related problems than their more accurate counterparts (Fisher's exact test, $p < .01$, *OR* = 7.61).

Online Casino Gambling

Descriptive statistics. The mean ages for gamblers who placed bets in online casinos were 35.14 years (*SD* = 11.53, range from 18 to 65) for the 3-month cohort and 33.74 years (*SD* = 10.26, range from 18 to 55) for the 12-month cohort. There was 1 (3%) woman in the 3-month cohort and 3 (6%) women in the 12-month cohort.

Table 5 summarizes the self-reported and actual outcomes for online casino play for the 3- and 12-month cohorts. Over their 3 months, gamblers in the 3-month cohort as a group lost 11,140 euros but believed they had lost 11,724 euros. This reflects an overestimation of the losses by 5%. Over their 12 months, gamblers in the 12-month cohort as a group lost 55,611 euros but believed they had lost 21,451 euros. This reflects an underestimation of losses by 39%.

As described in the Method section, we calculated the discrepancies between the actual net outcomes and the self-reported net outcomes. We assigned each online casino player a discrepancy score represented by the average bet size units. Table 6 summarizes the discrepancy scores for online casino play in average bet size units.

To avoid outlier effects on the results, we conducted a cluster analysis using absolute discrepancy to reveal online casino players who were exceptionally inaccurate in estimating their results. We compared these outliers with regular gamblers and analyzed them separately for most tests. The two-group cluster analyses revealed 2 exceptionally inaccurate online casino players among the 3-month cohort ("exceptionally inaccurate" cluster: *M* = 1,774.64, *SD* = 629.53; "regular" cluster: *M* = 59.92, *SD* = 129.09) and 3 exceptionally inaccurate online casino players among the 12-month cohort ("exceptionally inaccurate" cluster: *M* = 5,073.74, *SD* = 1,773.71; "regular" cluster: *M* = 160.56, *SD* = 329.62).

To address the question about the relationship between bias and absolute discrepancy, we conducted the Mann–Whitney *U* test for independent samples of individuals with favorable and unfavorable bias among "regular" (nonexceptional) gamblers. The results

Table 5
Self-Reported and Actual Net Outcomes for Online Casino Gambling for 3 and 12 Months Before the Survey (in Euros)

	3-month cohort (*N* = 35)		12-month cohort (*N* = 51)	
Variable	Actual net outcome	Self-reported net outcome	Actual net outcome	Self-reported net outcome
M (*SD*)	−318.27 (1,260.56)	−334.97 (1,024.72)	−1,090.41 (4,121.24)	−420.61 (1,165.92)
Minimum	−7,271.40	−5,500.00	−28,340.19	−5,000.00
Median	−14.00	−35.00	−44.09	−25.00
Maximum	217.00	350.00	760.50	1,000.00
Total	−11,139.45	−11,723.95	−55,610.91	−21,451.11

Table 6
Self-Reported and Actual Outcomes Discrepancy for Online Casino Gambling for 3 and 12 Months Before the Survey (in Average Bet Size Units)

	3-month cohort ($N = 35$)		12-month cohort ($N = 51$)	
Variable	Bias	Absolute discrepancy	Bias	Absolute discrepancy
M (*SD*)	27.95 (463.98)	157.90 (436.36)	374.60 (1,286.14)	449.57 (1,261.40)
Minimum	−1,329.49	0	−1,651.12	0
Median	0	12.53	6.71	19.77
Maximum	2,219.78	1,329.49	6,616.41	6,616.41

failed to reveal statistically significant results. This result did not support the hypothesis that estimation bias for gambling outcomes is associated with accuracy.

Age was positively related to number of active Online Casino betting days within the 12-month cohort, ρ (47) = 0.57, $p < .01$. Age was not associated with other variables. Due to the small number of women in the cohorts, we did not conduct gender analyses.

Hypotheses Testing

Hypothesis 1. Contrary to the prediction, online casino gamblers did not evidence different levels of estimation accuracy for their 12-month period and the 3-month period gambling results (3-month cohort: $M = 59.92$, $SD = 129.09$; 12-month cohort: $M = 160.56$; $SD = 329.62$; $p = .42$).

Hypothesis 2. The results for online casino bettors partially support the hypothesis that the majority of gamblers favorably bias their gambling outcomes. Half of gamblers positively bias their outcome estimates, whereas the other half demonstrates unfavorable distortion or precise estimates of their losses. About half of the gamblers (16 [49%] of the 33 in the 3-month cohort and 27 [56%] of the 48 in the 12-month cohort) were favorably biased. Of those who were favorably biased, almost all (15 [94%] from the 3-month cohort and 25 [93%] from the 12-month cohort) were losing players who underestimated their losses. The rest were winning players who overestimated their winnings. Sixteen (48%) of gamblers in the 3-month cohort and 11 (23%) of gamblers in the 12-month cohort were unfavorably biased. Of those, 10 (63%) of the unfavorably biased gamblers from the 3-month cohort and 6 (55%) of the unfavorably biased gamblers from the 12-month cohort were losing players who overestimated their losses. The rest were winning players who underestimated their winnings. About 16% of the gamblers (1 [3%] from the 3-month cohort and 10 [21%] from the 12-month cohort) precisely estimated their outcomes.

Of the 5 exceptionally inaccurate gamblers, one (20%) was unfavorably biased (from the 3-month cohort) and 4 (80%) were favorably biased (i.e., 1 from the 3-month cohort and 3 from the 12-month cohort).

Hypothesis 3. The findings failed to support the hypothesis that gambling experience is associated with self-report accuracy for Live Action gambling. On the contrary, absolute discrepancy score was correlated positively with total active days for both Online Casino cohorts; that is, 3 months: ρ (33) = 0.42; $p = .02$; 12 months: ρ (48) = 0.57, $p < .01$. This means that, for both the 3-month and 12-month cohorts, the more experienced gamblers less accurately estimated their gambling outcomes. We also examined the association between bias and total active days. We found that total active days was not associated with bias for the 3-month cohort, but there was a positive correlation between these two variables for the 12-month cohort, ρ (48) = 0.32, $p < .03$.

Hypothesis 4. The results failed to support the hypothesis that gamblers who inflate their winnings or minimize their losses were more likely to have gambling-related problems. A chi-square test did not reveal a significant association between BBGS status and type of gambler by self-report. We conducted Mann–Whitney *U* tests to examine whether we could detect a difference for inflation distortion for BBGS-Positives and BBGS-Negatives. The tests did not detect a difference either within the 3-month cohort or within the 12-month cohort.

Hypothesis 5. The results partially supported the hypothesis that low accuracy of self-reported gambling results is associated with gambling-related problems. Mann–Whitney *U* tests did not reveal significant differences between the distributions of absolute discrepancy between BBGS-Positives and BBGS-Negatives for either the 3-month cohort ($p = .42$) or the 12-month cohort ($p = .67$). However, of the 5 exceptionally inaccurate gamblers and 81 regular gamblers, 4 (80%) and 29 (36%), respectively, were BBGS-Positive. Exceptionally inaccurate online casino players were significantly more likely to experience gambling-related problems (Fisher's exact test, $p < .01$, $OR = 33.9$) than regular online casino bettors.

Cross-Game Analysis

Sports betting: Live action and fixed odds. There were 399 gamblers (20 women and 379 men) who placed both fixed odds and live action sports bets. There were 180 gamblers in the 3-month cohort (age: $M = 35.11$, $SD = 11.64$) and 219 gamblers in the 12-month cohort (age: $M = 35.11$, $SD = 10.98$). We calculated consistency scores for 136 gamblers in the 3-month cohort and 191 gamblers in the 12-month cohort. For the other 72 gamblers (44 in the 3-month cohort, 28 in the 12-month cohort), the consistency score was undefined.

To address the first research question about distorting (i.e., inflating or deflating) estimates of results for multiple games, we conducted a chi-square analysis comparing type of gambler by self-report for fixed odds sports betting to type of gambler by self-report for live action sports betting. The results showed no association between the two.

Table 7
Cross-Game Sports Betting Self-Report Consistency

Cohort	Consistently favorably biased *N* (%)*	Consistently unfavorably biased *N* (%)	Inconsistent *N* (%)	Consistently precise *N* (%)	Undefined *N* (%)	Total *N*
3-month	31 (17%)	44 (24%)	60 (33%)	1 (.5%)	44 (24%)	180
12-month	24 (11%)	62 (28%)	105 (48%)	0	28 (13%)	219
Total	55	106	165	1	72	399

Note. An asterisk indicates that totals % might not add to 100 due to rounding.

Table 7 describes the distribution of sports betting across game consistency. About one seventh of the gamblers consistently inflated their winnings or underestimated their losses across both types of sports betting (3-month cohort: $n = 31$ [17%]; 12-month cohort: $n = 24$ [11%]). About one quarter of the gamblers consistently evidenced deflating their winnings or overestimating their losses (3-month cohort: $n = 44$ [24%]; 12-month cohort: $n = 62$ [28%]). Of the 3-month cohort, 33% ($n = 60$) failed to evidence a consistent distortion style; of the 12-month cohort, 48% ($n = 105$) were similarly inconsistent (i.e., they did not employ consistent inflation and deflation distortions across games). One gambler from the 3-month cohort was precise in his estimations of both his fixed odds sports betting and live action sports betting results.

To address the possible association between gambling-related problems and consistent distortion types across games, we conducted the chi-square test using the variables sports betting consistency (consistently inflating, consistently deflating, consistently precise, or not consistent) and BBGS status. For both the 3-month and 12-month cohorts, sports betting consistency was not associated with BBGS status.

Three-game consistency: Fixed odds, live action, and online casino. There were 60 gamblers (2 women, 58 men) who played all three games. Twenty-four gamblers were in the 3-month cohort (age: $M = 32.31$, $SD = 9.70$), and 36 gamblers were in the 12-month cohort (age: $M = 32.67$, $SD = 10.29$). Fifteen of these gamblers (6 from the 3-month cohort, 9 from the 12-month cohort) were classified as accurate with respect to at least one out of the three forms of gambling. We classified the remaining 45 as consistent inflators, consistent deflators, or inconsistent. Table 8 describes the distribution of three-game cross-game consistency.

We conducted multiple chi-square analyses to examine if distorting gambling outcomes by overestimating or underestimating in one game predicted the same tendency for another game. However, there were no significant relationships within either the 3- or 12-month cohorts. Nine gamblers were consistent inflators across the three games (3-month cohort: $n = 2$ [8%]; 12-month cohort: $n = 7$ [19%]). About one-third was consistently pessimistic (3-month cohort: $n = 7$ [29%]; 12-month cohort: $n = 11$ [31%]). Among the 3-month cohort, 38% (9) of the gamblers were not consistent; for the 12-month cohort, 25% (9) were not consistent (i.e., they inflated their estimates of gambling outcome for at least one game and deflated their estimates for at least one other game). No gamblers were precise in all three games. Ten gamblers—6 (25%) from the 3-month cohort and 9 (25%) from the 12-month cohort—were precise in one or two games and were either favorably or unfavorably biased about the outcomes for the rest of their games.

There was no relationship between intergame estimation consistency and BBGS status.

Discussion

This study presents the first empirical research to compare individual self-reported and actual online gambling wins and losses. We analyzed three overlapping samples of online gamblers to test six hypotheses regarding the accuracy of self-reported gambling outcomes. The results revealed consistent support for the hypothesis that gamblers tend to be more accurate when they are asked about their short-term (i.e., 3-month) rather than long-term (i.e., 12-month) gambling outcomes. The results also supported the hypothesis that gamblers with gambling-related problems evidenced more discrepancies—both favorable and unfavorable—between self-reported and actual outcomes than did gamblers without these problems.

However, the results failed to provide conclusive support for any of the hypotheses related to "gambling optimism" (i.e., favorably biased perception of gambling outcomes). Specifically, these findings did not provide support for the notion that the majority of gamblers favorably distort their gambling outcomes. We also found no support for the hypothesis that those who do favorably

Table 8
Three-Game Cross-Game Self-Report Consistency

Cohort	Consistently favorably biased *N* (%)*	Consistently unfavorably biased *N* (%)	Inconsistent *N* (%)	Undefined *N* (%)	Total *N*
3-month	2 (8%)	7 (29%)	9 (38%)	6 (25%)	24
12-month	7 (19%)	11 (31%)	9 (25%)	9 (25%)	36
Total	9	18	18	15	60

Note. An asterisk indicates that totals % might not add to 100 due to rounding.

distort their gambling outcomes for a single game or consistently across different games evidence more gambling-related problems than do gamblers who do not favorably bias the outcome of their wagers. Finally, the findings also did not support the hypothesis that gambling experience is positively related to the accurate perception of gambling outcomes.

From a clinical perspective, these findings support the observation that short-term memory is more accurate than long-term memory (e.g., Murre, Janssen, Rouw, & Meeter, 2013; Schacter, 1995). Clinicians and scientists alike would be wise to evaluate the presence of gambling problems by assessing possible signs and symptoms of the disorder on a past-year or shorter time frame. In addition, contrary to conventional wisdom, clinicians should not assume that gamblers consistently bias their recall of gambling events to generate a favorable self-impression. As this study shows, making such an assumption would be incorrect and would hold the potential to diminish the therapeutic alliance. However, treatment providers would be wise to consider the distortion of gambling outcomes as a central feature of gambling disorder, whether these distortions are favorable or unfavorable.

In the discussion that follows, we begin by presenting an overall view of accuracy and its relationship to gambling-related problems and follow with a more detailed discussion of the results.

Overall Accuracy and Gambling-Related Problems

This study revealed that, overall, self-reported gambling-related problems are associated with accuracy bias for estimating sports betting results that is independent of the specific overestimation or underestimation bias. For example, sports bettors who report having some gambling-related problems estimate their results less accurately than sports bettors who do not report any such problems. In addition, extremely inaccurate sports bettors and online casino players—both those who favorably and those who unfavorably bias their estimates of gambling outcomes—were more likely to report gambling-related problems. Gambling problems and cognitive bias have long been recognized as associated (Ladouceur, Sylvain, Letarte, Giroux, & Jacques, 1998; Ladouceur & Walker, 1998; Sylvain, Ladouceur, & Boisvert, 1997). A full literature review is beyond the scope of this discussion; our evidence suggests that attention, memory, and other cognitive systems also might be involved. More research is necessary to clarify these processes and examine how the relationships among them influence gamblers and gambling. Understanding these relationships holds important potential to advance prevention and treatment efforts. For example, screening programs and treatment programs alike should examine various sources of information (e.g., reports from significant others, casino statements, credit cards) to objectively determine the extent of discrepancy between gamblers' self-report and their actual winnings and losses. Assessments should include a discussion of these discrepancies, affording clinicians the opportunity to engage in more detailed evaluation with gamblers who substantially overestimate or underestimate their losses and winnings. Further, prevention programs should include discrepant self-reports related to wins and losses as a warning sign for the presence of gambling-related disorders. Finally, online gambling providers could work toward developing prevention programs that compare actual and self-reported gambling outcomes to identify risk levels for gambling-related problems and provide opportunities for intervention.

Estimating Gambling Outcomes for Longer Versus Shorter Periods

Overall, our findings provided mixed support for previous research showing that individuals report their expenditures more accurately for shorter time periods (Blaszczynski et al., 2008; Williams & Wood, 2004a). Our results supported this pattern for sports betting but not for online casino play. It is possible that the small sample size of the online casino cohort did not provide enough statistical power to reveal an estimation bias across games.

Distribution of Gamblers' Biases

Contrary to common belief, our analysis did not support the notion that the vast majority of gamblers overestimate their winnings and underestimate their losses. We observed that, across the games, approximately half of the gamblers favorably biased and, to our surprise, 23% to 48% of the gamblers unfavorably biased their estimates of gambling results.

Gambling Experience and Outcome Estimation

We examined whether gambling experience was associated with accurate estimates of gambling outcomes. The results revealed that more experienced sports bettors and online casino players evidenced more inaccurate estimates of gambling outcomes than did less experienced gamblers. This finding suggests that those who estimate wins and losses less accurately tend to play more. Alternatively, a negative correlation between estimation accuracy and gambling experience could reflect the fact that individuals who place more bets have more difficulty recalling and aggregating their results than do those who place fewer bets. More research is necessary to clarify these and other possible associations.

In addition, we examined whether experienced gamblers tend to distort their estimates of gambling outcomes more favorably than do less experienced players. Only analyses of the live action sports bettors revealed a positive association between gambling experience and favorable bias toward gambling outcomes and, more specifically, only in the case of the 12-month cohort. Individuals who perceive their gambling results more favorably might be more likely to play more. Alternatively, individuals with more wagers and a history of longer playing sessions are more likely to experience memorable stretches such as windfalls, upswings, and winning streaks. These short-term betting history features might influence their overall perception of net results toward a more favorable direction. Prospective, rather than retrospective, research is necessary to clarify the associations among these potential moderators and mediators that influence the association between gambling experience and the accuracy of estimating gambling outcomes.

Favorable Bias and Gambling-Related Problems

This study revealed that favorable bias toward gambling outcomes did not relate to reports of gambling-related problems. For example, fixed odds sports bettors in the 3-month cohort who overestimated their losses or underestimated their winnings (i.e., demonstrated unfavorable bias) were more likely to self-report gambling-related problems than those who underestimated their losses or overestimated their winnings (i.e., demonstrated favorable bias). In addition, gamblers who were consistently unfavorably biased when estimating their expenditures for both sports betting games were more (rather than less) likely to report gambling-related problems. It is likely that individuals who believe they have gambling-related problems also believe they have lost money due to their gambling. In other words, some gamblers believe they have problems because their unfavorable estimation bias leads them to believe that they have lost substantial amounts of money. To clarify this association and the mediators of this relationship, researchers will need to conduct a prospective longitudinal study examining whether favorable or unfavorable bias mediates the emergence of future gambling-related problems.

Intergame Estimation Differences

Our results revealed important differences among game types with regard to the average underestimation or overestimation of losses. We observed that, with both the 3-month and 12-month cohorts, on average, live action sports bettors reported losing less than they actually did (i.e., favorable bias by discounting losses). Those who reported their online casino losses during a 12-month period also, on average, reported losing less than their actual amounts. However, those who reported the results of online casino play during 3 months overestimated their results by inflating losses (i.e., unfavorable bias). Similarly, both the 3- and 12-month cohorts for fixed odds sports betting also evidenced an unfavorable bias by reporting losses greater than their actual results.

Previous research has identified similar intergame bias differences. Many studies focusing on gambling self-report accuracy reported an average underestimate of losses among gamblers (Wood & Williams, 2007). However, as with our current results, not all studies found that gamblers underestimate their losses. Some studies reported overestimation of losses. For example, using total gaming revenue, Canadian gamblers reported losing twice as much money as was reported by the industry (Williams & Wood, 2004b). Washington state residents similarly reported losing up to 10 times more than revenue projections (Volberg, Moore, Christiansen, Cummings, & Banks, 1998). In addition, previous studies have reported substantial accuracy differences for self-reported expenditures across games. For example, in a National Opinion Research Center survey, on average, respondents reported winning money in racetrack betting and private gaming but losing money in lotteries (Gerstein et al., 1999). Similarly, in another study, gamblers reported that their expenditures for gaming machines and horse racing were below what an analysis of total gaming revenues predicted, and expenditures for lottery products, bingo, and raffles were higher than similarly predicted by industry revenue reports (Williams & Wood, 2004b). These previous studies used aggregate industry revenues, instead of actual individual-level expenditures, as the standard against which estimation accuracy is judged. The present study advances the field by identifying similar intergame differences using actual wagers, wins, and losses at the individual level of analysis.

To our best knowledge, no previous study has examined self-reported expenditures for fixed odds sports betting. Therefore, we cannot determine whether overestimating online fixed odds sports betting losses is a unique characteristic of (a) this particular sample of fixed odds players among bwin.party subscribers or (b) fixed odds gambling in general. Future studies will need to pay closer attention to the differences between games regarding the accuracy of estimations of expenditures. Controlled laboratory experiments that force people to play different games and recall their results afterward might help clarify this issue.

We also examined whether gamblers who participated in multiple games evidence favorable or unfavorable estimation bias consistently across all game types. We observed that evidencing consistently unfavorable bias was more frequent than evidencing consistently favorable bias. We observed this tendency both among those who participate in the two sports betting games (i.e., fixed odds sports betting and live action sports betting) and those who participated in all three game types (i.e., fixed odds sports betting, live action sports betting, and online casino play). We found no correlation between the consistency of favorable or unfavorable reporting and gambling-related problems. Further research should include studies of individuals' gambling portfolios and possible associations with gambling-related and game-specific problems.

Limitations

As with all research, this study has some limitations. One primary limitation of our study is that it is based on a retrospective data analysis. This research strategy permits us to demonstrate estimation patterns for gambling outcomes but not the course, duration, or mechanisms that mediate these patterns. Another important limitation is that this study uses a sample derived from only one online gambling provider. Most subscribers of bwin.party use it for sports betting. Consequently, online casino gamblers are underrepresented among the bwin.party's subscribers. In addition to potentially limiting the representativeness of this sample, the small group of casino players limits the statistical power available for group comparisons. Another limitation of this sample is the very small number of women, which in turn restricted our ability to investigate whether gender influenced estimation accuracy. Finally, we made a distinction between the exceptionally inaccurate and regular gamblers on the basis of a statistical procedure (i.e., cluster analysis). This distinction might be an artifact of this procedure and not an accurate reflection of the essence of gambling disorder (American Psychiatric Association, 2013).

Conclusion

In sum, the current study advances the field by providing the first investigation to examine the accuracy of estimating actual gambling expenditures at the individual level. Specifically, this study is the first to use actual expenditures to investigate gamblers who overestimate, underestimate, or provide precise estimations of their gambling expenditures. The results fail to support the commonly held and perhaps simplistic belief that most gamblers just underestimate their gambling losses. Our findings show that, although gamblers often deceive themselves regarding their gambling financial outcomes, they frequently overestimate their losses as well as underestimate them. According to our data, a gambler's overall inaccuracy for estimating losses and gains is a better predictor of gambling-related problems than whether he or she evidences a particular pattern of overestimation or underestimation. Finally, this study opens new research opportunities that hold the potential to improve our understanding of the mechanisms that influence estimation bias and its relationship to gambling-related problems.

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Received July 1, 2013
Revision received February 11, 2014
Accepted February 13, 2014 ■